Small Group Exercises
Case Study Booklet

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Case Study #1: Sea Level Rise Adaptation Strategy For Honolulu Historic Core

Background Information:
Located on the southwest coast of Oahu, the area near downtown Honolulu includes historic buildings and sites related to settlement by Native Hawaiians, unification of the islands and establishment of the Hawaiian Monarchy, first contact with Westerners, missionary activities, Territorial government and State capital buildings, businesses and early utility company headquarters. The adjacent Chinatown Historic District adds another layer of richness to the narrative of place with cultural sites that contribute to telling the "immigrant story" in the downtown area. Central Honolulu hosts many of the most significant cultural institutions for Oahu and the State of Hawaii, including some of its oldest buildings. Museums, royal palaces of the Hawaiian Monarchy, the state library, state courthouse and state capitol building are all located here. While many pre-contact sites were lost following the establishment of Honolulu as both an important regional trade hub and primary seat of several governing bodies, their memory and sense of importance remain in placenames. The historic core sits on a low-lying marshy plane of eroded volcanic soil and fill atop coral limestone bedrock between the Punchbowl crater and the southern entrance of Honolulu Harbor.

Problem:
The Honolulu Historic Core is particularly susceptible to sea level rise due to its proximity to the shoreline, its low elevation, and the sheer number and density of historic sites and buildings that will be impacted. While widespread inundation is unlikely in the near term, the area is threatened by extreme weather events and so-called sunny-day flooding (when head pressure from high tides percolates through subsurface soils overwhelming storm drains). The porous bedrock in this area renders dykes and seawalls largely ineffective for purposes other than storm surge protection. Many buildings and sites in this area are located at +/- 1.5 meter above sea level and are therefore at imminent risk. While some buildings further inland, including the State Capitol, sit +/-3 meters above sea level or higher, they remain at risk due to systemic weaknesses in urban infrastructure including roads, power, water, sewerage, and storm drain systems, all of which will need to be redesigned and upgraded to withstand sea level rise of 1 meter or more.

Sea Level Rise Projections:
.5 Meters = 2025-2100 1 Meter = 2050-2150 2 Meters = 2100-2200
*While the specific timeframe for future sea level is challenging to estimate, these benchmarks include overlapping date ranges that encompass a broad spectrum of predictive models.

Prompt:
What considerations should be included when developing a strategy for Honolulu's Historic Core for various sea level rise scenarios and associated frequency/intensity of extreme weather events? How would your considerations evolve when considering the short (25 year plan), medium (50 year plan), and long term (100 year plan)?

Questions to Guide Discussion:
- What would be your guiding strategy for considering a plan for sea level rise in Honolulu's Historic Core?
    - Strategies for the historic district could include: defend, rebuild, relocate, record, retreat.
    - How might your approach change over time?
- The Honolulu Historic Core is one of the most important and broadly representative historic districts in the city, on the island, and in the state. How does the status of this place influence your though processes?
    - Is it possible to evaluate the problem realistically given the likely passion and connection people have to the sites?
- At what point do preservation strategies negatively influence our experience and connection to place?
- How would you balance preservation goals with the need to maintain and improve civic infrastructure? What strategies are independent actions by the city/state/federal government?
- What does preservation mean in the face of an inexorable and global threat such as sea level rise where so much of our collective history and connection to places is threatened?

Case Study #2: Ocean Air and Big Waves at Eneen'kio (Wake Atoll)

Background Information:
Wake Atoll is approximately 690 miles north of Kwajalein. The atoll, about 5 miles long and 2.5 miles wide, sits approximately 18 feet above sea level. Archaeological evidence suggests the atoll has never been permanently inhabited as there is no fresh water available. Marshallese voyagers, the earliest known visitors, travelled to the atoll to obtain the orange flower after which they named the atoll, Eneen'Kio. European seafarers first made their way to the atoll in 1568 and they occasionally returned through the nineteenth century. The United States claimed the atoll in 1899. The US began construction of a Navy Air Station in early 1941; however, construction was interrupted on December 8, 1941, when Japanese attacked Wake Atoll following their attack on Pearl Harbor. American forces at Wake fell to the Japanese on December 23, 1941. Japanese forces developed intensive defensive structures, including pillboxes, revetments, anti-aircraft control centers, shelters and magazines, tank trenches and living quarters. American forces later blockaded Wake Atoll. Many Japanese became ill, starved and/or died.

The atoll has been home to several military and civilian missions over the past 70 years. It is still used as an emergency divert airfield. The entire Atoll has been designated a National Historic Landmark (NHL). The Wake Atoll National Historic Landmark derives its significance from the World War II battles and development of trans-Pacific air transportation. Easily visible historic structures include concrete buildings, Japanese officer domestic features, batteries, pill boxes and gun emplacements.

Problem:
Wake Atoll has some of the best-preserved stacked stone defensive features in the Pacific; however, several pillboxes and other defensive features are now within the tidal zone or have succumbed to it. The condition of other World War II American and Japanese forces historic sites have suffered due to recent tidal surges and erosion. Tidal surges have battered foundations associated with the original 1941 US Navy Air Station. The USAF has plans to move and rebuild residential and support facilities, as they flood occasionally. The USAF staff is still assessing conditions of the NHL historic properties and updating documentation and inventory. The staff is working to stabilize and rehabilitate the structures to illustrate and preserve the history of these important events.

Sea Level Rise Projections:
The monthly extreme water levels include a Mean Sea Level (MSL) trend of 2.07 millimeters/year which is equivalent to a change of 0.68 feet in 100 years.

Prompt:
Imagine you are a cultural resources manager at Wake Atoll. How could the U.S. Air Force preserve the Wake Atoll National Historic Landmark in the face of coastal inundation?

Questions to Guide Discussion:
- What communities do you think have ties to Wake Atoll? How do you think these communities might differ when it comes to preservation values?
- Who would you consult with when developing management strategies for the NHL?
    - Which communities value these resources?
    - What types of resources might these communities value and why?
- What strategies would you consider when considering a plan for sea level rise in Wake Atoll's NHL?
    - Strategies for the NHL district could include: defend, rebuild, relocate, record, retreat
    - At what point do we allow coastal inundation to take over rather than continue to expend resources on a case such as this?
    - How would you recommend stabilizing or rehabilitating concrete and stacked stone structures? What about oxidized metals?
- Since Wake Atoll is not publicly accessible, how should that factor into preservation strategies?
    - How could documentation and other technologies to record the site allow for public education and awareness?
- What does preservation mean in the face of an inexorable and global threat such as sea level rise where so much of our collective history and connection to places is threatened?

Case Study #3: Sea Level Rise Adaptation Strategy for Pu'uhonua O Hōnaunau National Historical Park

Background Information[4]
Pu'uhonua o Honaunau National Historical Park (PUHU) is a historically sacred Hawaiian site, dating to as early as 1450 CE and valued by Hawaiians as a place where those breaking a kapu, or prohibition, could take refuge from society. Located on the southwest coast of the island of Hawai'i, the site now includes a total of 420 acres and contains the remains of temple platforms, fishponds, sledding (he'e hōlua) tracks, and the archaeological remains of coastal village sites. The site resides on the shoreward slope of a relatively recent gently inclined lava outflow partially covered by a modest layer of volcanic ash and effluvia, upslope eroded particulate material, and beach sand. To the north lies Keone'ele Cove, a small artificially nourished beach with a nearshore basalt platform used by sea turtles for sunbathing. This cove was an ancient royal canoe landing area and is now managed by the National Park Service.

Problem:
Pu'uhonua O Hōnaunau National Historical Park is particularly susceptible to sea level rise and increased storm damage due to its location at the shoreline. A collection of buildings, archeological sites, and historic landscape modifications including fortifications, water management systems, gardens, fishponds, and a protected lagoon is at risk of erosion, storm damage, and eventual inundation. Likewise, archeological excavations, cultural sites, and buildings that continue to be used for both religious-cultural practices and interpretive or expository functions are located at +/- 1 meter above sea level and are therefore at immediate risk. While some buildings including a visitor's center with exhibition and performance space and several archeological sites sit +/-2 meters above sea level or higher, they are also at imminent risk. Over a distance of approximately 500 meters from the shoreline, the inland slope directly adjacent to the park rises to more than 30 meters.

Sea Level Rise Projections:
.5 Meters = 2025-2100 1 Meter = 2050-2150 2 Meters = 2100-2200
**While the specific timeframe for future sea level is challenging to estimate, these benchmarks include overlapping date ranges that encompass a broad spectrum of predictive models.*

Prompt:
Anticipated increases in sea level, extreme weather events, and increased ocean temperatures due to global climate change require new approaches to preserving near-coastal cultural heritage, historic buildings, and archeological sites. What considerations should be included when developing a strategy for the future of Pu'uhonua O Hōnaunau National Historical Park for various sea level rise scenarios and anticipated increases in both the frequency and intensity of extreme weather events?

Questions to Guide Discussion:
- What would be your guiding strategy for considering a plan to address sea level rise in Pu'uhonua O Hōnaunau National Historical Park?
    - Strategies for the historic park could include: defend, rebuild, relocate, record, retreat
    - How might PUHU approach rebuilding? What makes rebuilding unique in this case?
    - How might your approach changes over the short, medium, and long term?
- Who would you consult with when developing management strategies for the park?
    - Which communities value these resources?
    - What types of resources might these communities value and why?
- What makes an organization a responsible steward?
    - Can you be a responsible steward without taking active steps to defend or preserve something from storms and flooding?
- How might the park's interpretation of the sites change given anticipated sea level rise trends?
- At what point do preservation strategies negatively influence our experience and connection to place?
- What does preservation mean in the face of an inexorable and global threat such as sea level rise where so much of our collective history and connection to places is threatened?

Case Study #4: Cultural Preservation Strategy for a Disappearing Nation - Kwajalein Atoll

Background Information:
The Republic of the Marshall Islands is composed of 29 coral atolls and five islands with an average elevation of roughly 2m (6ft) above sea level. First discovered 1,200 BCE, the islands have been continuously inhabited for over 3,000 years ago. The Marshallese people have had contact with Westerners as early as the 1520's to include Spanish, British, German, and American sailing vessels.

In 1875, Great Britian gave Germany control over the Marshall Islands, leading to formal annexation as a colony around 1885. The Japanese government seized administrative control over the Marshall Islands in 1914 and deployed military forces throughout the islands during World War II. The United States wrested control of the Marshall Island from the Japanese in 1944 and governed the islands as part of a UN Trusteeship of Strategic Areas. The United States conducted 67 nuclear tests in the Marshall Islands and studied the impacts of radiation on the health of Marshallese exposed to nuclear fallout.

The US military headquarters is located in Kwajalein Atoll, the largest atoll in the world and one of the historical capitals of the Marshallese traditional leadership. In addition to developing the United States nuclear missile capabilities, the Department of Defense (DoD) base on Kwajalein monitors aircraft and missile launches around the Pacific, tracks orbiting satellite and space debris, and serves as the "bullseye" for calibrating America's nuclear missile arsenal. Kwajalein also is home to one of five ground base stations that ensure the accuracy of the GPS (Global Positioning System) navigating system.

At the end of World War II, there were fewer than 100 Marshallese living on Kwajalein Atoll. By 1975, over 7,000 Marshallese were living on Ebeye, the local community next to the American base. Current Marshallese populations range from 9,000 to 12,000 with 10,000 being an often-quoted estimate.

The American and Marshallese living situation in Kwajalein Atoll is a "Tale of Two Cities." 1,250 American service members and military contractors live on the 768-acre Kwajalein Island in cinderblock/concrete buildings with indoor plumbing, reliable electrical and internet service. Roughly 10,000 Marshallese live on the 80-acre island of Ebeye in structures ranging from cinderblocks to corrugated tin roofs with plywood walls without running water intermittent power, sometime 30 to 40 individuals to a household. Every morning, roughly 1,000 Marshallese workers take the ferry to work for the Americans on Kwajalein Base and return to their crowded homes on Ebeye before sundown.

Problem:
In 2018, the DoD Strategic Environmental Research and Development Program (SERDP) conducted a study of an overwash event on Roi-Namur, one of the military bases in Kwajalein. They determined: *the "tipping point" – the time at which potable groundwater on Roi-Namur will be unavailable – is projected to be reached before 2035 for the RCP8.5+icesheet collapse climate scenario, the 2030-2040 time frame for the RCP8.5 climate scenario, and 2055-2065 for the RCP4.5 scenario.*

As much of the Marshall Islands is the same geological formation and elevation as Kwajalein Atoll, this means that Marshallese communities will no longer be able to draw freshwater from ground wells as early as 2035 and in no case after 2065. As the freshwater lens disappears, terrestrial flora and fauna will disappear rendering the entire nation uninhabitable sandbars. As if to highlight the point, Roi-Namur was hit by another overwash event 20 January 2024 that disrupted operations and forced the evacuation of military personnel.

While climate change driven sea level rise ensures the destruction of the Marshall Islands as a nation by the end of the century, warming seas also increase the frequency and/or intensity of storms in the Pacific. In 1991, Tropical Storm (TS) Zelda struck Kwajalein Atoll leaving an estimated 6,000 of 10,000 Marshallese homeless. In 2015, NASA Earth Observatory identified three Cat 4 (>130 mph) typhoons in the Pacific at the same time for the first time in recorded history. There is a statistical likelihood that a 1991 TS Zelda equivalent will strike Kwajalein Atoll again before the collapse of the freshwater lens forces all the Marshallese to leave.

Prompt:
Given that climate change driven ecosystem collapse of the Marshall Islands will force the local population to leave their homelands within a generation (30 years), how will humanity keep the 3,000-year-old Marshallese language, culture, and history alive?

Questions to Guide Discussion:

- What ethical responsibility does humanity have to protect and preserve the histories, languages, and cultures of climate vulnerable peoples? Why?
    - Who determines which cultures to "save"? (Does the host nation have a voice?)
    - Who should pay the costs? (How does one compel payment?)
- The United States is climate hardening the Kwajalein Base on Kwajalein. Does the DoD have any obligation to also climate harden the nearby Marshallese communities? Why?
- Given the probability that overwash events, intensifying tropical storms, and sea level rise will eventually submerge the Marshall Islands, what are the logical decision points for defend, rebuild, relocate, record, retreat?
- What are some potential "win-win" implementation strategies to ensure a peaceful "death of a nation"?
- What, if any, compensation should be considered for Marshallese descendants?
- What does preservation mean in the face of an inexorable and global threat such as sea level rise where so much of our collective history and connection to places is threatened?